Chapter 10.A: File-System Interface

Chapter 10.A: Outline

- File Concept
- Access Methods
- Disk and Directory Structure
- File-System Mounting
- File Sharing
- Protection

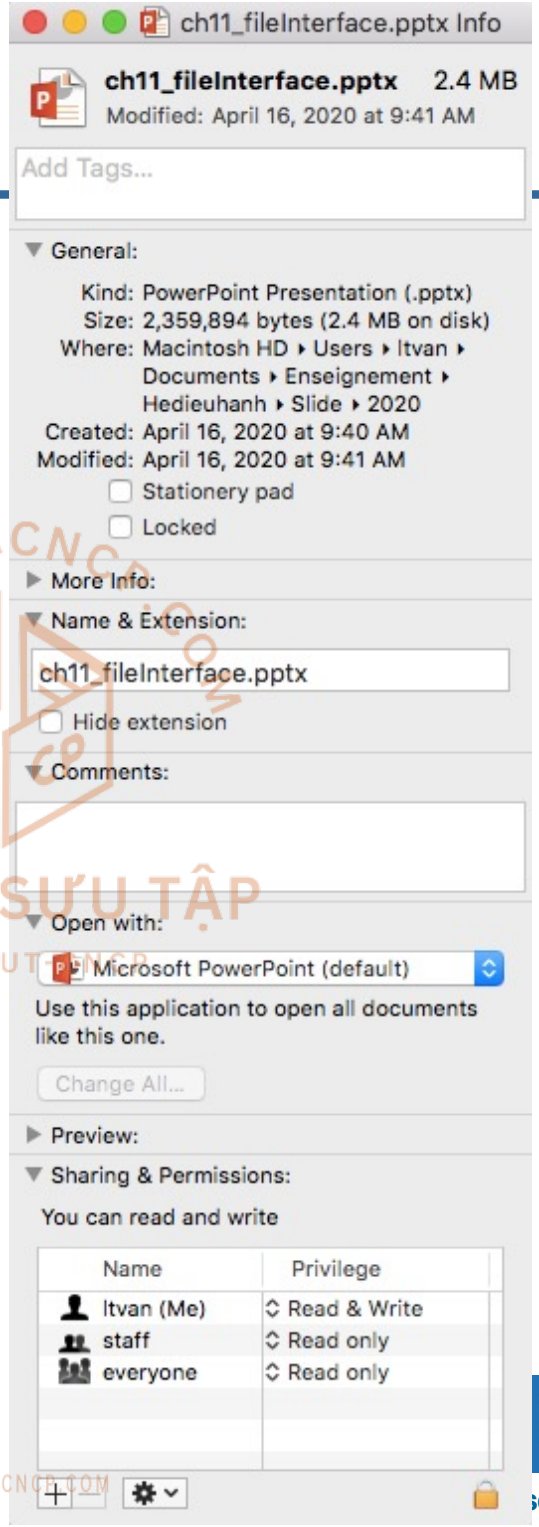
File Concept

- Contiguous *logical address space*
- Types:
  - Data
    - complex
    - numeric
    - character
    - binary
  - Program
- Contents defined by file's creator
  - Many types
    - Text file
    - Source file
    - Executable file

File Attributes

- *Name* – only information kept in human-readable form
- *Identifier* – unique tag (number) identifies file within file system
- *Type* – needed for systems that support different types
- *Location* – pointer to file location on device
- *Size* – current file size
- *Protection* – controls who can do reading, writing, executing
- *Time, date, and user identification* – data for protection, security, and usage monitoring
- Information about files are kept in the directory structure, which is maintained on the disk
- Many variations, including extended file attributes such as file checksum

A window of file info on Mac OS X



File Operations

- File is an *abstract data type*
  - *Create*
  - *Write* – at write pointer location
  - *Read* – at read pointer location
  - *Reposition* within file (or seek)
  - *Delete*
  - *Truncate*
- *Open*(F_i) – search the directory structure on disk for entry F_i, and move the content of entry to memory
- *Close*(F_i) – move the content of entry F_i in memory to directory structure on disk

Open Files

- Several pieces of data are needed to manage open files:
  - *Open-file table*: tracks open files
  - *File pointer*: pointer to last read/write location, per process that has the file open
  - *File-open count*: counter of number of times a file is open – to allow removal of data from open-file table when last processes closes it
  - *Disk location of the file*: cache of data access information
  - *Access rights*: per-process access mode information

File Types – Name, Extension

file type	usual extension	function
executable	exe, com, bin or none	ready-to-run machine-language program
object	obj, o	compiled, machine language, not linked
source code	c, cc, java, pas, asm, a	source code in various languages
batch	bat, sh	commands to the command interpreter
text	txt, doc	textual data, documents
word processor	wp, tex, rtf, doc	various word-processor formats
library	lib, a, so, dll	libraries of routines for programmers
print or view	ps, pdf, jpg	ASCII or binary file in a format for printing or viewing
archive	arc, zip, tar	related files grouped into one file, sometimes compressed, for archiving or storage
multimedia	mpeg, mov, rm, mp3, avi	binary file containing audio or A/V information

File Structure

- *None* - sequence of words or bytes
- *Simple record structures*
  - Lines
  - Fixed length
  - Variable length
- *Complex structures*
  - Formatted document
  - Relocatable load file (i.e., executable file)
- Can simulate last two with first method by inserting appropriate control characters
- Who decides:
  - Operating system
  - Program

Access Methods

- *Sequential Access*

  `read next`

  `write next`

  `reset`

  no read after last write (rewrite)

- *Direct Access* – file is *fixed-length logical records*

  `read n`

  `write n`

  `position to n`

  `read next`

  `write next`

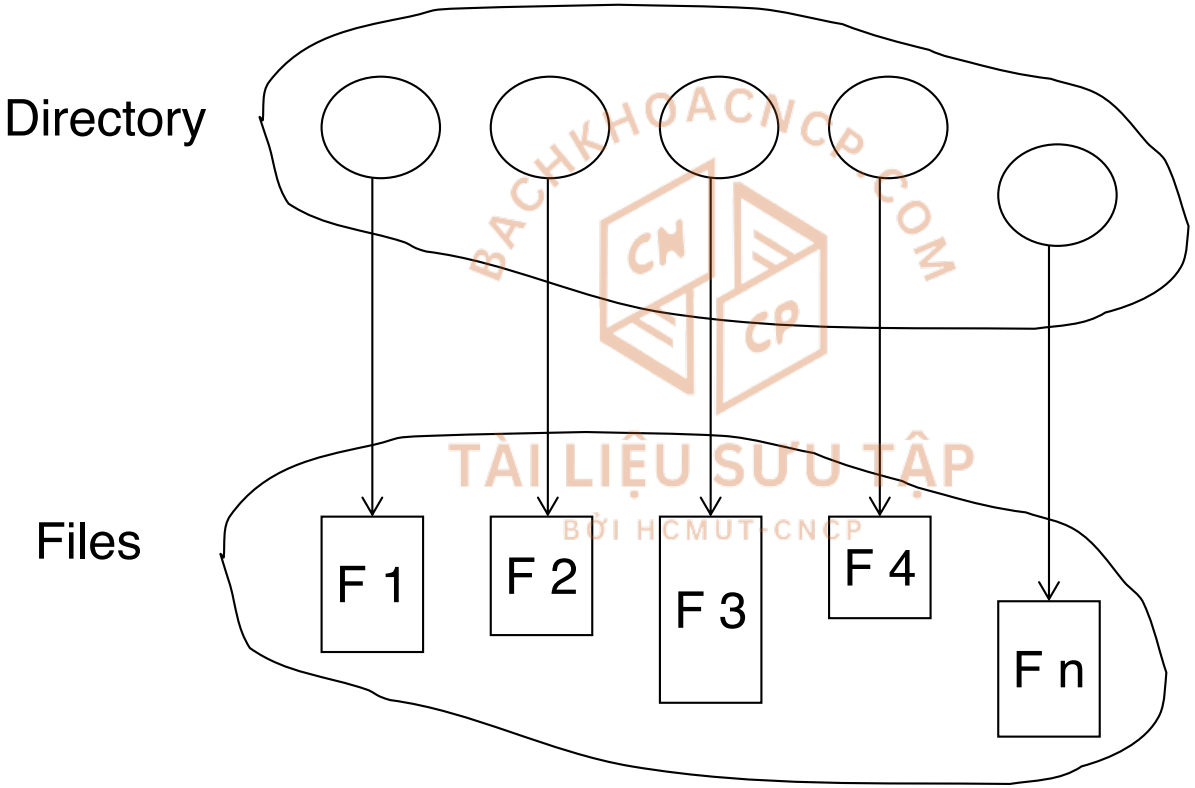
  `rewrite n`

  n = *relative block number*

  - Relative block numbers allow OS to decide where file should be placed
  - See *allocation problem* in Chapter 12

Directory Structure

- A *collection of nodes* containing information about all files

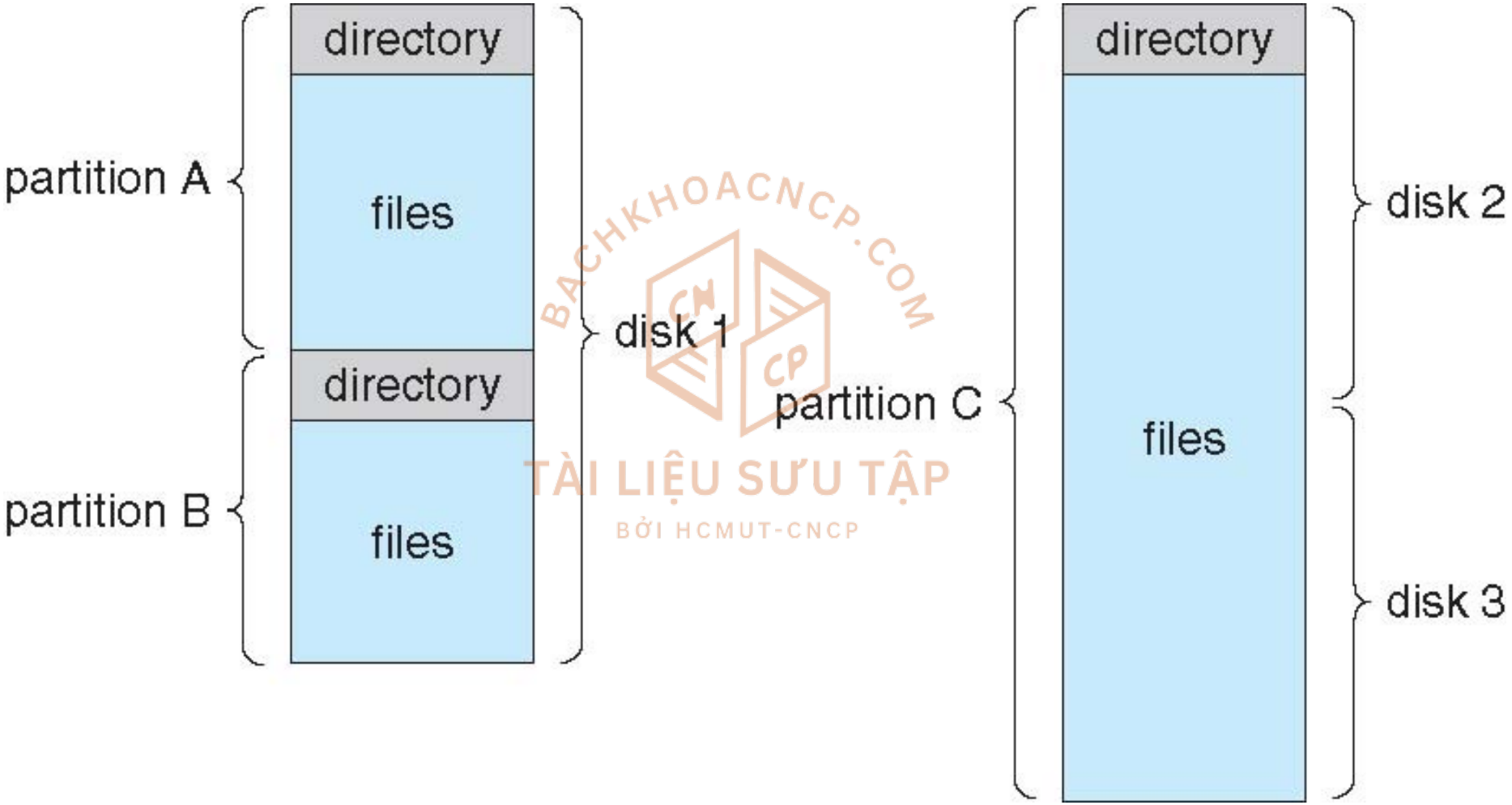


Both the directory structure and the files reside on disk

Disk Structure

- *Disk* can be subdivided into *partitions*
  - Disks or partitions can be **RAID** protected against failure
  - Disk or partition can be used *raw* – without a file system, or *formatted* with a file system
- Partitions also known as minidisks, slices
- Entity containing file system known as a *volume*
  - Each volume containing file system also tracks that file system's info in device directory or volume table of contents
- As well as general-purpose file systems there are many special-purpose file systems, frequently all within the same operating system or computer

A Typical File-System Organization



Operations Performed on Directory

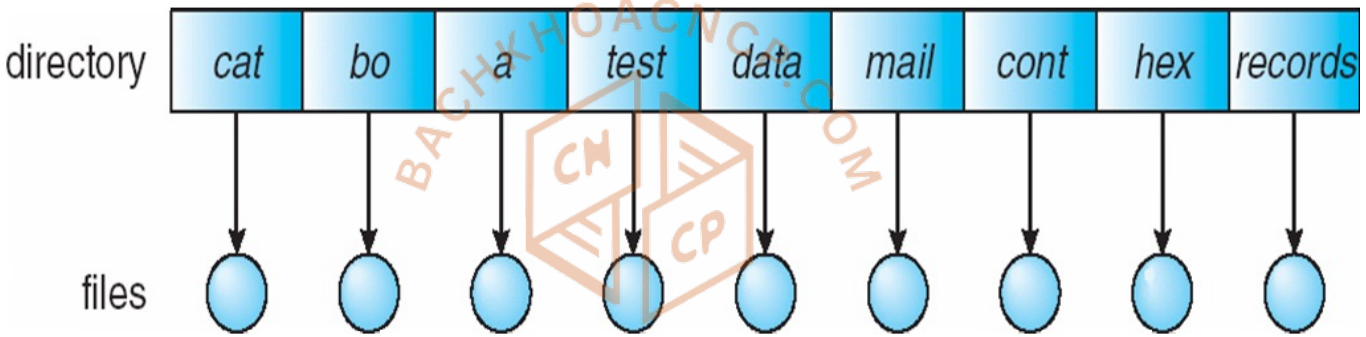
- *Search* for a file
- *Create* a file
- *Delete* a file
- *List* a directory
- *Rename* a file
- *Traverse* the file system

Directory Organization

- The directory is organized logically to obtain
  - *Efficiency* – locating a file quickly
  - *Naming* – convenient to users
    - Two users can have same name for different files
    - The same file can have several different names
  - *Grouping* – logical grouping of files by properties, (e.g., all Java programs, all games, …)

Single-Level Directory

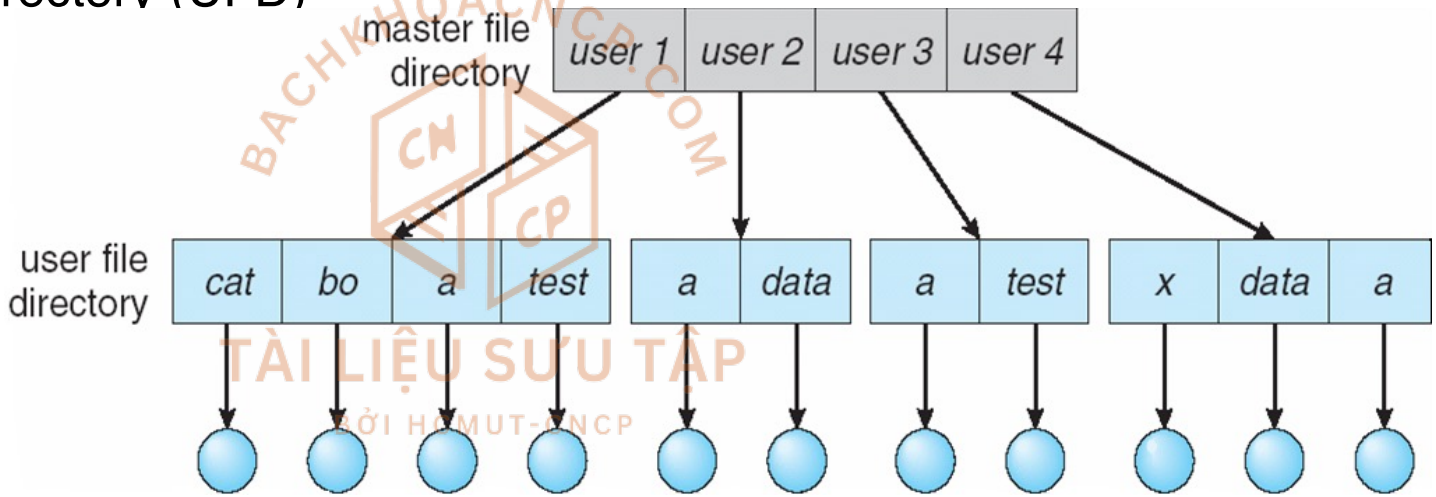
- *A single directory for all users*



- Naming problem
- Grouping problem

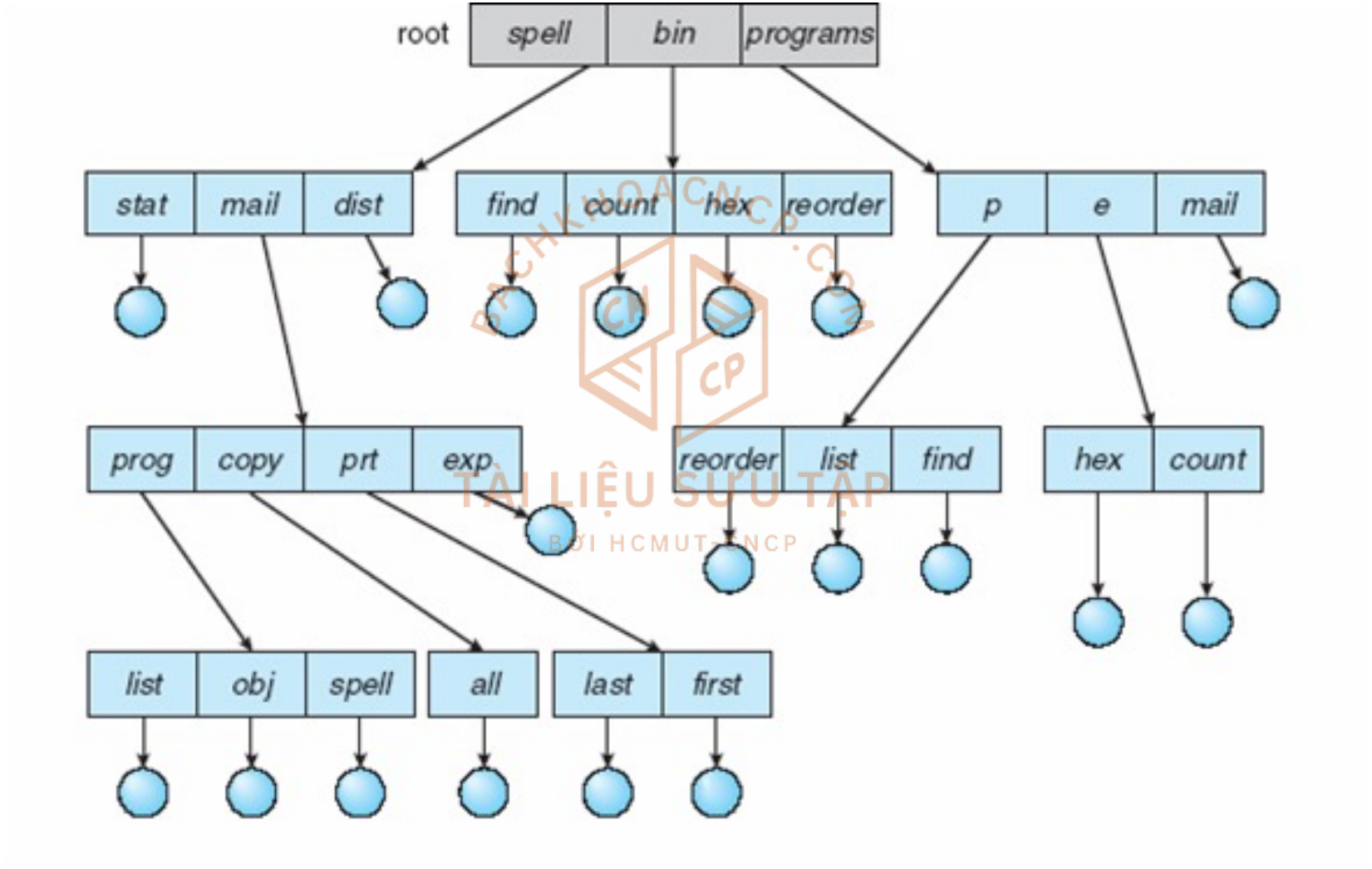
Two-Level Directory

- *Separate directory for each user*
  - Master file directory (MFD)
  - User file directory (UFD)



- Path name
- Can have the same file name for different user
- Efficient searching
- No grouping capability

Tree-Structured Directories



Tree-Structured Directories (Cont.)

- Efficient searching
- Grouping Capability
- Current directory (or working directory)
  - E.g., For Linux OS,

```
cd /spell/mail/prog
type list
```


Tree-Structured Directories (Cont.)

- Using *absolute* or *relative* path name
- Creating a new file is done in current directory
- Delete a file

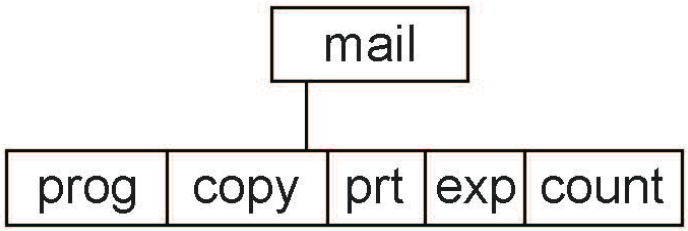
```
rm <file-name>
```

- Creating a new subdirectory is done in current directory

```
mkdir <dir-name>
```

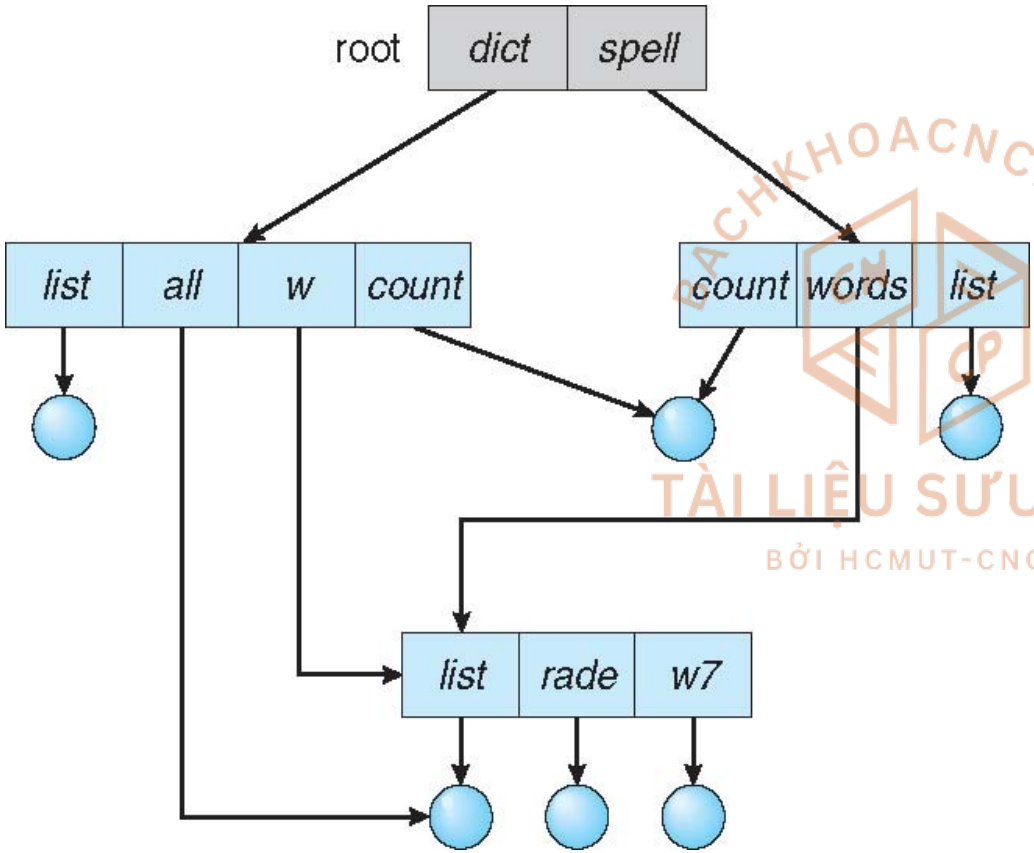
  - Example: if in current directory **/mail**

```
mkdir count
```



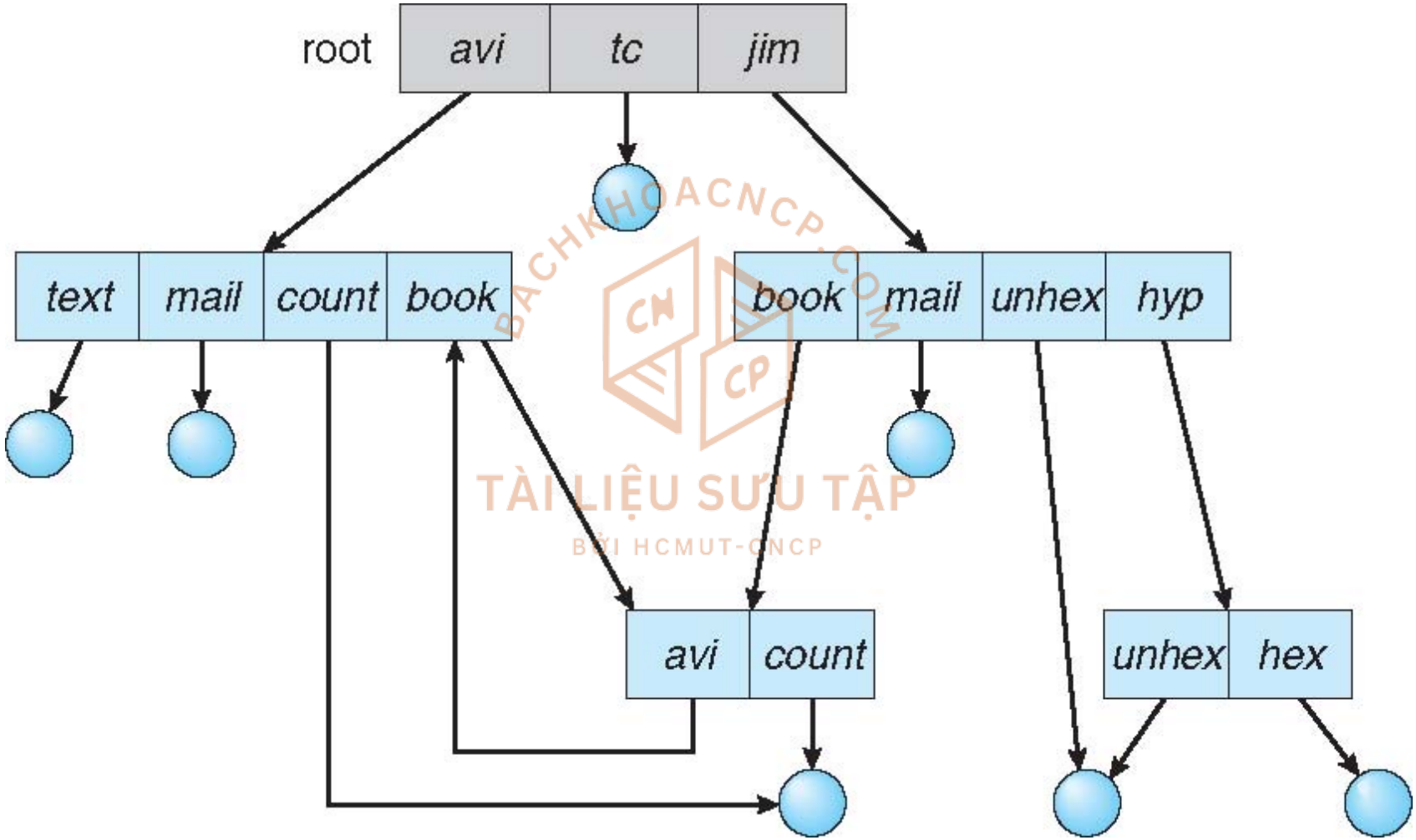
    - Deleting "mail" ⇒ deleting the entire subtree rooted by "mail"

Acyclic-Graph Directories



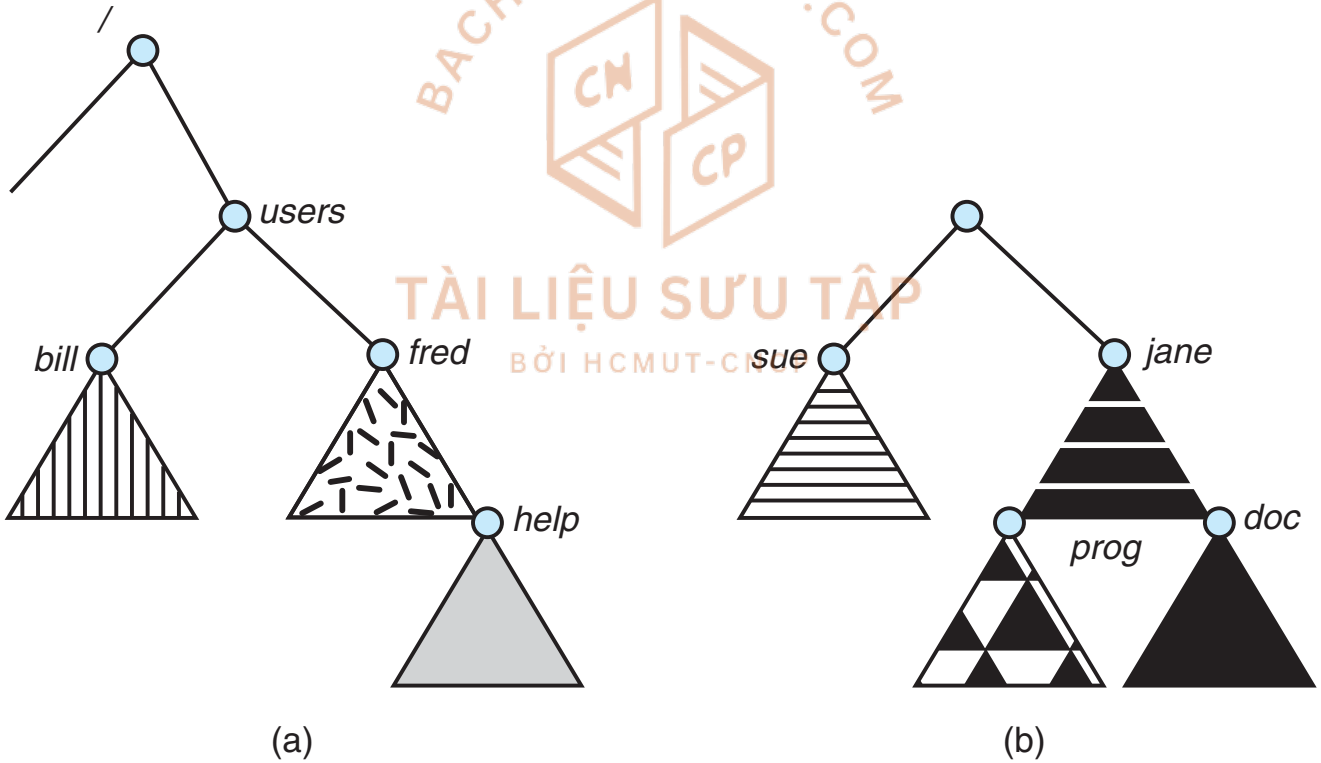
- Have shared subdirectories and files
  - Two different names (*aliasing*)
    - If *dict* deletes *list* ⇒ dangling pointer.

General Graph Directory



File System Mounting

- A file system must be *mounted* before it can be *accessed*
- A unmounted file system (i.e., Fig. (b)) is mounted at a mount point



File Sharing

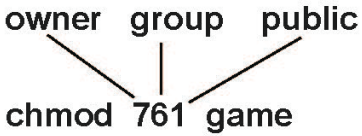
- Sharing of files on *multi-user systems* is desirable
- Sharing may be done through a protection scheme
- On distributed systems, files may be shared across a network
  - *Network File System* (**NFS**) is a common distributed file-sharing method
- If multi-user system
  - Owner of a file / directory
    - *User IDs* identify users, allowing permissions and protections to be per-user
  - Group of a file / directory
    - *Group IDs* allow users to be in groups, permitting group access rights

Protection

- *File owner/creator* should be able to control:
  - what can be done
  - by whom
- *Types of access*
  - Read
  - Write
  - Execute
  - Append
  - Delete
  - List

Access Lists and Groups

- Mode of access: *read* (R), *write* (W), *execute* (X)
- Three classes of users on Unix / Linux



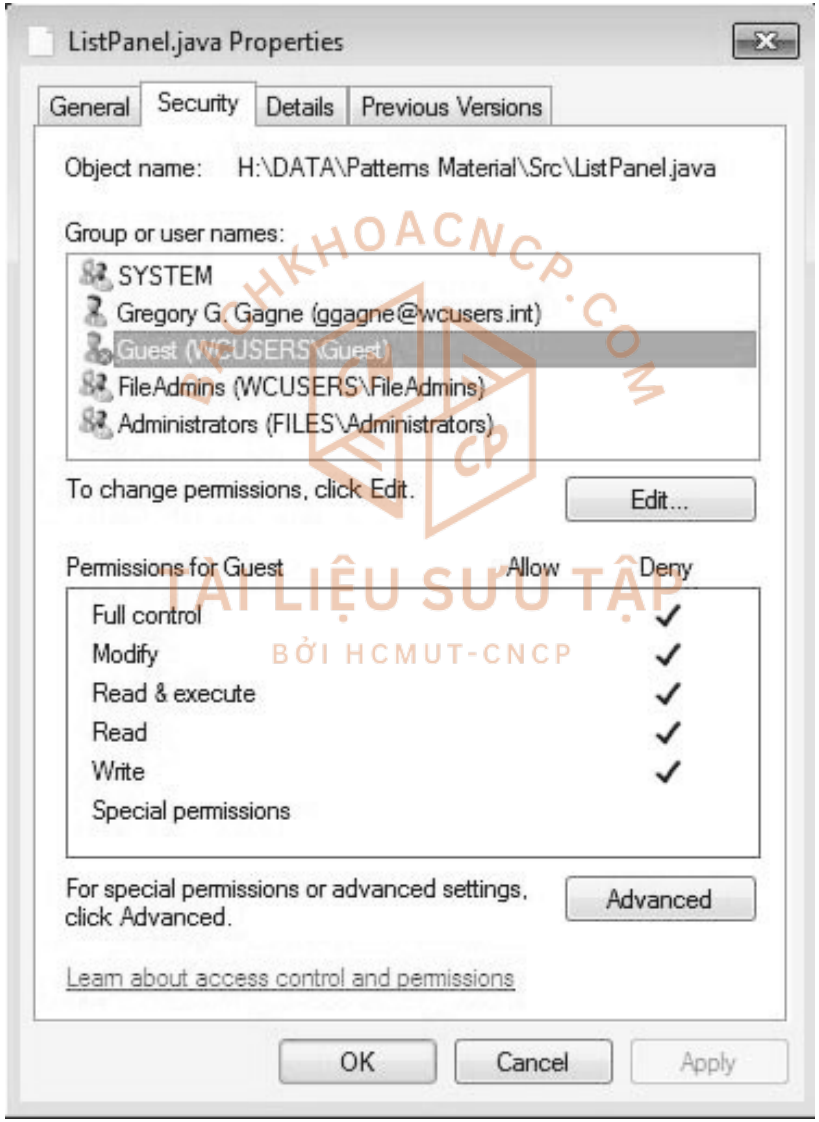
			RWX
a) **owner access**	7	⇒	1 1 1
b) **group access**	6	⇒	RWX 1 1 0
c) **public access**	1	⇒	RWX 0 0 1

- Ask manager to create a group (unique name), say G, and add some users to the group.
- For a particular file (say *game*) or subdirectory, define an appropriate access.

Attach a group to a file

```
chgrp    G    game
```

Windows 7 Access-Control List Management



A Sample UNIX Directory Listing

```
-rw-rw-r--    1 pbg    staff    31200  Sep 3 08:30   intro.ps
drwx------    5 pbg    staff      512  Jul 8 09.33   private/
drwxrwxr-x    2 pbg    staff      512  Jul 8 09:35   doc/
drwxrwx---    2 pbg    student    512  Aug 3 14:13   student-proj/
-rw-r--r--    1 pbg    staff     9423  Feb 24 2003   program.c
-rwxr-xr-x    1 pbg    staff    20471  Feb 24 2003   program
drwx--x--x    4 pbg    faculty    512  Jul 31 10:31  lib/
drwx------    3 pbg    staff     1024  Aug 29 06:52  mail/
drwxrwxrwx    3 pbg    staff      512  Jul 8 09:35   test/
```

End of Chapter 10.A